Not to be cited without
permission of the authors[1]

Ne pas citer sans
autorisation des auteurs[1]

DFO Atlantic Fisheries
Research Document 96/69

MPO Pêches de l'Atlantique
Document de recherche 96/69

Growth and condition of cod in Subdivision 3Ps as determined from trawl surveys (1972-1996) and sentinel surveys (1995)

by

G.R. Lilly

Science Branch, Department of Fisheries and Oceans
PO Box 5667, St John's,Newfoundland
Canada, A1C 5X1

[1]This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

[1]La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problémes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas étre considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisé dans le manuscrit envoyé au secrétariat.

104-07139/

Abstract

The growth and condition of cod in Subdivision 3Ps were monitored by sampling catches during winter-spring research bottom-trawl surveys in the offshore in 1972-1996 and sentinel surveys in the inshore in 1995. In the offshore, length-at-age peaked in the mid to late 1970s and varied with no trend (younger ages) or declined slightly (older ages) during the past decade. Condition, as measured by both gutted body weight and liver weight relative to length, was low in fish sampled during the 1993-1996 surveys. However, it is not clear that the values were below normal, because the 1993-1996 surveys were conducted in April when condition is near the low point of the seasonal cycle, and only one of the earlier surveys was conducted at about the same time. The condition of fish sampled from the sentinel surveys varied seasonally and spatially. The quantity of food in stomachs of cod sampled during the sentinel surveys was generally low. A dramatic increase in stomach fullness occurred in July when the cod fed on capelin. Liver index reached a peak at that time.

Résumé

Il a été procédé à un contrôle de la croissance et de la condition des morues de la sous-division 3Ps par échantillonnage des captures des relevés de recherche hauturiers au chalut de fond d'hiver et de printemps de la période 1972-1996 et de celles des pêches sentinelles côtières de 1995. Dans la zone hauturière, le paramètre de la longueur selon l'âge a atteint un maximum du milieu à la fin des années 1970 et a ensuite varié sans présenter de tendance (classes plus jeunes) ou a légèrement diminué condition (classes plus âgées) au cours de la dernière décennie. Le facteur de condition, déterminé à partir du poids après éviscération et du poids du foie en fonction de la longueur, était faible chez les poissons des relevés de 1993-1996. In n'est cependant pas certain que ces valeurs soient inférieures à la normale car les relevés de cette période ont été réalisés en avril, au moment où le facteur de condition est au plus bas de son cycle saisonnier, et seulement un des relevés antérieures avait été effectué à une période semblable. Le facteur de condition des poissons des relevés sentinelles était généralement faible. Une augmentation extrêmement importante de ce contenu a été notée en juillet, lorsque les morues se nourrissent de capelans. L'indice basé sur le poids du foie a aussi présenté un pic à ce moment.

Introduction

Cod (Gadus morhua) in several areas of Atlantic Canada experienced pronounced declines in growth and condition during the late 1980s and early 1990s. The extent to which similar changes were experienced by cod off the south coast of Newfoundland (Subdivision 3Ps) has not been determined, even though sampling for length-at-age has been conducted during research bottom-trawl surveys since 1972 and sampling of weight-at-length and weight of individual body parts has been conducted since 1978. The first purpose of this paper is to describe the sampling which has been conducted during winter-spring assessment surveys, and to present summary information on annual changes in length-at-age, weight-at-age, weight-at-length (condition) and weight of liver.

The second purpose is to describe the sampling conducted during the sentinel surveys in the inshore regions of Subdivision 3Ps in 1995, and to report temporal and spatial variability in condition, liver index and stomach contents.

Materials and Methods

Research vessel surveys

Survey design

Cod were caught during stratified-random bottom-trawl surveys conducted in Subdivision 3Ps during winter-spring 1972-1996. The timing of the surveys varied considerably, with the earliest and latest dates of fishing being January 27 in 1988 and June 12 in 1975 (Table 1). The median dates of fishing varied from February 7 to June 6. The number of fishing stations also varied considerably, from a low of 44 in 1978 to a high of 166 in 1994. The number of stations tended to be lower in the 1970s and early 1980s. Note that there were two surveys in 1993; one in February and one in April. Only the latter has been included in the time-series.

The survey gear was changed twice during the period 1972-1996. The 51 m side trawler R.V. 'A. T. Cameron' (1972-1982) deployed a Yankee 41-5 trawl, the sister 50 m stern trawlers R.V. 'Alfred Needler' (1983, 1984) and R.V. 'Wilfred Templeman' (1985-1995) deployed an Engel-145 high-lift trawl, and in 1996 the R.V. 'Wilfred Templeman' deployed a Campelen trawl with rockhopper foot gear. In all instances, a 29 mm mesh liner was inserted in the codend. In 1972-1995, tows were made at 3.5 knots for 30 min at each fishing station, whereas in 1996 tows were made at 3.0 knots for 15 min. Catches from the few stations of non-standard duration were appropriately adjusted. Fishing in all years was conducted on a 24-h basis.

Fishing stations were allocated randomly within depth strata, with a new station selection being conducted each year. The number of stations allocated to each stratum was roughly proportional to the size of the stratum, with the constraint that each stratum be allocated no fewer than 2 stations. (There were instances in which the sampling objectives were not realized.)

Doubleday (1981) provides illustrations of the strata and information on their areas and depth-ranges. Several additions and modifications to the stratification scheme are described by Bishop (1994) and Murphy (1996).

Biological sampling

Sampling of cod for otoliths and various biological attributes was conducted using two distinct procedures (Table 2). The first involved determination of biological attributes (eg. fork length, cm) and the extraction of otoliths at sea. The second, which was started in 1978, involved the determination of body length at sea followed by the freezing of the fish for detailed examination in the laboratory at the Northwest Atlantic Fisheries Centre, St. John's. These frozen fish were thawed in fresh water and weighed (to the nearest 10 g) before being cut (round weight) and again after removal of the organs from the abdominal cavity (gutted weight). The liver and gonad were also weighed (g) or measured volumetrically (ml).

For each of these two methods of sampling, there were several changes in what constituted a sample and several changes in the biological attributes measured. With respect to the sampling of unfrozen fish, a single sample was obtained for the whole Subdivision during 1972-1984, two samples were obtained during 1985-1987, and a single sample was obtained in 1988-1996. With respect to the sampling of frozen fish, a single sample was obtained for the whole Subdivision during 1978-1984, two samples during 1985-1988, three samples during 1989-1993 (February), four samples in 1993 (April) and five samples in 1994-1996. The boundaries of the sample areas varied over time, and in some years (notably 1985-1988) several strata were not included in any of the samples.

For the period 1978-1984, all information regarding body weight or the size of individual body parts came only from the frozen fish. Additional information was collected at sea starting in 1985. From 1985-1989, the volumes of the liver and gonad were determined with volumetric cylinders for all fish sampled at sea. In 1990, balances for weighing at sea were first used to obtain round weight, gutted weight, and weights of large livers and gonads for all fish sampled at sea. The sizes of small (<100 g) livers and gonads continued to be determined volumetrically. In 1991 and subsequent years, weights were obtained for livers and gonads of all sizes. An important change for the frozen fish, initiated in 1991, was the determination of round weight at sea prior to freezing.

The number of aged fish for which body length, body weight and liver size (weight or volume) were determined in each year is given in Table 3. The number of aged fish for which length and round weight were determined are given for each year and age in Tables 4 and 5 respectively.

Data analysis

Mean lengths at age were calculated by weighting individual measurements in the biological sample by the ratio of the population number per 3 cm length class to the number of fish sampled in the same length class, where the population number was calculated by areal

expansion of the stratified mean catch at length per tow (Smith and Somerton 1981). Mean weights at age were calculated by weighting each individual fish weight by the ratio of the population number per 3 cm length class to the number of fish sampled in the same length class. Note that weights were not obtained in 1972-1977 and that in 1978-1989 the number of fish for which weights were recorded is smaller than the number measured.

The condition of each fish was expressed using Fulton's condition factor ($(W/L^3)*100$), where W is round or gutted weight (kg) and L is length (cm). The relative size of the liver (liver index) was expressed the same way. Mean condition at age was calculated by weighting each individual fish condition by the ratio of the population number per 3 cm length class to the number of fish sampled in the same length class.

Sentinel surveys in 1995

Biological sampling

Sentinel surveys for cod were conducted by fishing enterprises operating from 15 communities in Subdivision 3Ps during the winter-summer (February-July) and autumn (September-December) of 1995 (Davis 1995). To obtain information on feeding and well-being, samples of cod were collected by 14 of these enterprises, frozen and transported to the Northwest Atlantic Fisheries Centre in St. John's. The objective during the winter-summer period was to obtain one sample of 2 fish per cm from each location every two weeks. The objective remained unchanged during the autumn, except that the sampling rate was reduced to 1 fish per cm.

The frozen fish were thawed in fresh water and weighed (to the nearest 10 g) before being cut (round weight) and again after removal of the organs from the abdominal cavity (gutted weight). The liver and gonad were also weighed (g). The stomach contents were separated into species or higher taxa, and the specimens in each taxon were counted and weighed to the nearest 0.1 g.

Data analysis

The condition and liver index were calculated as described above.

The relative importance of specific prey taxa was expressed as percent occurrence (number of stomachs containing the prey as a percentage of the total number of stomachs, including empty stomachs), percent by weight (weight of specific prey in all stomachs as a percentage of the total weight of all prey in all stomachs) and as a partial fullness index (Fahrig et al. 1993):

$$PFI_i = \frac{1}{n}\sum_{j=1}^{n}\frac{W_{ij}}{L_j^3} * 10^4$$

where W_{ij} is the weight (g) of prey i in fish j, L_j is the length (cm) of fish j, and n is the number of fish in the sample. This index is based on the assumption that stomach capacity is a power function of length, and is analogous to Fulton's condition factor. The total fullness index (TFI) is the sum of all partial fullness indices.

Results and Discussion

Research vessel surveys

Mean lengths at age

Mean lengths-at-age (Table 6; Fig. 1) varied over time. For the period 1972-1996, peak length-at-age occurred in the mid-1970s for young ages (3-4) and progressively later to 1980 for older ages. During the past decade, length-at-age varied with no trend (younger ages) or declined (older ages). The changes in mean weights-at-age (Table 7; Fig. 2) appear very similar to those for mean lengths. Further examination of variability in growth will focus on lengths only, because there is evidence that the weight of the muscle mass and liver undergo changes during the winter-spring period (see section on condition).

There are some unexpected year effects in the length-at-age data, as illustrated in a plot of the increase in length of individual cohorts (Fig. 3) and a plot of annual length increments for ages 2 to 8 (Fig. 4). There appears to be negative growth for at least 2 cohorts during each of the intervals 1977-1978, 1980-1981, 1989-1990 and 1993-1994. Apparent negative growth could result from decreased availability of the larger fish within each cohort. This could be caused by relatively high mortality of larger fish or differences in migration patterns of larger and smaller fish within each cohort. Apparent negative growth could also result if the survey area contained different "groups" of fish with different growth rates, and the proportion of each group in the sampling varied from year to year. There is good evidence that the 3Ps stock consists of several stocks or substocks, but it has not yet been demonstrated that these smaller units experience different growth rates. There is also a possiblity that the degree of inclusion of adjacent stocks may vary from year to year. Pinhorn (1969) reported that cod from Burgeo Bank grow faster than those from 3Pn, and the degree to which 3Pn4RS cod occur within 3Ps probably varies among years (D'Amours et al. 1994). There may also be annual variability in the presence of 3NO cod, which grow relatively quickly (Fleming 1960).

Additional exploration of the annual variablity in length increments followed the approach of Shelton and Lilly (1995) and Shelton et al. (1996). A multiplicative model accounting for age effects was fitted to the logarithm of the annual increments,

$$\mathrm{Ln}(X_{ij}) = \alpha_i + \varepsilon ,$$

where X_{ij} is the mean length increment at age i in year j, α_i is the age effect, and ε is normally distributed error. Analysis was limited to ages 2 to 6, because length at age 1 was usually based on a small sample size and was sometimes missing, and growth at ages greater than 6 was

sometimes negative. The model explained 26% of the variance in the logarithm of the annual length increments (Table 8). The mean annual residuals (Fig. 5) show some of the effects noted above. For example, the three strongest negative residuals (1977, 1989, and 1993) occurred during years when apparent negative growth was observed in older ages. The negative residual in 1995 may be related to the change in gear from the Engels high lift trawl to the Campelen trawl. The latter trawl is much more effective at catching small fish.

There are several factors which may have contributed to the observed differences in growth. (1) As noted above, it is possible that the sampling of different "groups" of fish varied among years. The distribution of sampling relative to the distribution of different "groups" of cod should be investigated. (2) The timing of the surveys differed among years, so the duration between samples varied considerably. However, this may not present a problem, because there are reasons to suspect that increase in length does not occur during the winter-spring period. Pinhorn (1966) reported that otolith growth of west Newfoundland cod, caught off southwestern Newfoundland, starts in July and continues until December. Condition (somatic condition and liver index) of cod taken in the 1995 sentinel survey decreased during the winter-spring (see below), and it is unlikely that linear growth would occur while condition was declining. Average spawning time for cod on St. Pierre Bank is mid-May (Hutchings and Myers 1994), and again it is unlikely that linear growth would occur in mature cod at a time when they put much of their energy into reproduction. In addition, cod sampled during several of the winter-spring bottom-trawl surveys had little food in their stomachs (unpubl. data). Despite these reasons for suspecting that linear growth does not occur during the period over which the surveys have varied, a check for the influence of differences in duration between successive surveys should be conducted. (3) A third factor which may have caused some of the annual variability in length-at-age is temperature, which is a strong determinate of growth in northern cod and other cod stocks (Shelton et al. 1996, and references therein). Time-series of temperature are provided by Hutchings and Myers (1994) and Colbourne (1996), but perhaps the influence of temperature on growth should not be investigated until there is resolution of the questions noted above regarding sampling of different "groups" of fish and the possible influence of differences in survey timing.

Cod well-being

Gutted condition: Mean gutted condition at age (Table 9; Fig. 6) generally fluctuated without trend. Values tended to be high in some years, notably 1983, and low in other years, especially 1993 and 1994. Among-year comparisons are confounded by the considerable differences in timing of the surveys. As a preliminary examination of the influence of timing, the mean condition for each of three 9-cm length-groups was plotted against the median date of the survey (Fig. 7). There appears to be a slight decline from the earliest median date (day 56 - February 25) to approximately day 105 (mid-April), after which there is an increase. Thus, the low values in recent years (1993-1996) may be due primarily to the timing of the surveys. This interpretation must be tested further, because condition levels tended to be relatively high in 1984, the only earlier year in which the survey was conducted at about the same time as the 1993-1995 surveys.

Liver index: Mean liver index at age (Table 10; Fig. 8) had a stronger year-to-year pattern than did gutted condition. The high values of 1983 are more pronounced and there is a strong peak in

the late 1980s and early 1990s. When mean liver index is plotted against median survey date (Fig. 9), there is a distinct decline to approximately day 105, followed by an increase. As with the gutted condition, the low values in recent years are seen to result from sampling at the nadir of the seasonal cycle.

Sentinel surveys in 1995

Cod well-being

Samples were collected by fishing enterprises operating from 14 communities (Table 11). Samples were obtained by each enterprise on 2-14 occasions, yielding a total of 126 collections and 2903 fish. Individual samples consisted of 1-58 fish (median =23).

Because Fulton's condition increases with cod length, it is necessary to employ a relatively narrow range of fish length when examining spatial and temporal variability in condition. The cod sampled during the surveys varied from 18 to 104 cm (Table 11). Cod from linetrawls had a broader size range than those from gillnets, but cod from the latter tended to be larger (Fig. 10). This is probably the result of differences in gear selectivity, but the possibility of spatial differences in availablility of fish by size cannot be ruled out, because at no time were the two gears fished side-by-side. For analysis of condition, a length range of 45-71 cm was arbitrarily chosen. (The boundaries may seem odd, but they are chosen to facilitate comparison with data collected during offshore surveys, where samples for condition were collected by 3-cm length-groups prior to 1994 and samples for stomach content analysis were collected by 9-cm length-groups.)

Both gutted condition and liver index underwent a seasonal cycle, with a low point in spring (probably in May) and a peak in summer (Fig. 11). The peak is very poorly defined because of the paucity of sampling. Cod caught west of the Burin Peninsula (dark symbols in Fig. 11) appear to have lower liver indices in the first half of the year than do cod caught in Placentia Bay. There is considerable variability in condition during the autumn. This was also the case with cod caught during the autumn 1995 sentinel survey in Division 2J3KL (Lilly 1996).

Stomach contents

Most of the sampled cod had very little food in their stomachs (Table 12). The average total fullness index for all 2545 stomachs combined was just 0.53, which is very low considering that values as high as 20 have been found in individual cod and average values greater than 10 have been found in certain samples, particularly those taken from cod which had been feeding intensively on capelin in the inshore (Lilly and Osborne 1984). However, a low level of stomach fullness is not unusual for cod in the inshore at times other than when capelin are available (Lilly and Botta 1984).

The most frequently occurring prey were hyperiid amphipods. Prey which contributed most to the weight of the pooled stomach contents were capelin (Mallotus villosus), hyperiids,

ophiuroids (brittle stars), snow crabs (Chionoecetes opilio) and toad crabs (Hyas araneus and H. coarctatus). The major contributors to the fullness index were capelin and hyperiids. Commercial fish other than capelin included redfish (Sebastes sp.), herring (Clupea harengus) and cod. There were several species of shrimp, the most important of which was Lebbeus polaris. It must be emphasized that Table 12 is a summary of the stomach contents of those cod sampled during the sentinel surveys. Extrapolation to the prey composition of the population of cod in the inshore regions of Subdivision 3Ps will require several additional steps, including adjustments for the length-stratified sampling, some adjustment for the selection characteristics of the gears, and a weighting of each sample to account for temporal/spatial variability in fish density. The paucity of data from the summer period, when feeding may be most intense, precludes any attempt at calculating the prey composition of the cod population at this time.

The total fullness index and the partial fullness indices for eight categories of stomach contents (including bait) are provided for each sample in Table 13. The total fullness index was low in most samples. Two high values (6.8 at Monkstown on July 6 and 6.6 at St. Brides on July 19) are associated with intensive predation on capelin. The highest value for the liver index (0.069) also came from the St. Brides sample on July 19. A rapid increase in liver index occurs when cod feed intensively on capelin in inshore waters during the early summer (Lilly 1996; unpubl. data). Most of the moderately high TFI values (ie. those between 1.0 and 2.0) are associated with feeding on capelin or hyperiid amphipods.

It must be emphasized that the above descriptions of condition and feeding are only initial attempts at understanding these aspects of the cod's life in inshore waters. These data must be examined in relation to other observations on the actual fishing grounds (as opposed to simple reference to the community from which each fishing enterprise operated). Other observations of interest include C/E data, tag return data, cod length-at-age (and hence growth), stage of maturity and various quantitative and qualitative observations regarding the physical and biotic environment.

Were any cod in critical condition?

Some of the gutted condition levels and liver indices found during the sampling in Subdivision 3Ps appear low compared with levels observed in offshore and inshore cod of Divisions 2J3KL (Taggart et al. 1994; Lilly 1996). Data must accrue for several years before the seasonal pattern of "normal" condition levels can be determined for both 3Ps cod and 2J3KL cod, and before it can be determined if there are regional differences in timing and amplitude of these cycles. Note that accurate determination of the cycles will require sampling at each site throughout the year, with sampling perhaps being most frequent during the times of spawning and intense feeding (spring and summer).

It is not yet known if any of the condition levels found during this study are indicative of fish in critical condition. Dutil et al. (1995) have provided metrics for what they consider to be fish in a jeopardized state, based on their laboratory studies of Gulf of St. Lawrence cod, but the condition formulations which they have used cannot be applied directly to the data available for

cod in Subdivision 3Ps. Following additional analyses, it should be possible to make certain simplifying assumptions and cast the data for 3Ps cod in a way which permits direct comparison with their values.

References

Bishop, C. A. 1994. Revisions and additions to stratification schemes used during research vessel surveys in NAFO Subareas 2 and 3. NAFO SCR Doc. 94/43. Serial No. N2413. 23 p.

Colbourne, E. 1996. Oceanographic conditions in NAFO Subdivisions 3Pn and 3Ps during 1995 and 1996 with comparisons to the long-term (1961-1990) average. (this meeting)

D'Amours, D., K. T. Frank, and G. Bugden. 1994. Report of the working group on oceanographic effects on stock migration and mixing - reviewed by the Fisheries Oceanography Committee (FOC). DFO Atl Fish. Res. Doc. 94/54. 52 p.

Davis, M. B. 1995. Preliminary results from the inshore sentinel surveys for cod in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 95/67. 7 p.

Doubleday, W. G. (ed.) 1981. Manual on groundfish surveys in the Northwest Atlantic. NAFO Sci. Coun. Studies 2: 7-55.

Dutil, J.-D., Y. Lambert, G. A. Chouinard, and A. Fréchet. 1995. Fish condition: what should we measure in cod (Gadus morhua)? DFO Atl. Fish. Res. Doc. 95/11. 26 p.

Fahrig, L., G. R. Lilly, and D. S. Miller. 1993. Predator stomachs as sampling tools for prey distribution: Atlantic cod (Gadus morhua) and capelin (Mallotus villosus). Can. J. Fish. Aquat. Sci. 50: 1541-1547.

Fleming, A. M. 1960. Age, growth and sexual maturity of cod (Gadus morhua L.) in the Newfoundland area, 1947-1950. J. Fish. Res. Board Can. 17: 775-809.

Hutchings, J. A., and R. A. Myers. 1994. Timing of cod reproduction: interannual variability and the influence of temperture. Mar. Ecol. Prog. Ser. 108: 21-31.

Lilly, G. R. 1996. Condition of cod in Divisions 2J+3KL during the autumns of 1978-1995. NAFO SCR Doc. 96/48. Serial No. N2723.15 p.

Lilly, G. R., and J. R. Botta. 1984. Food of Atlantic cod (Gadus morhua L.) near Bonavista, Newfoundland in 1983. NAFO SCR Doc. 84/51, Serial No. N838. 8 p.

Lilly, G. R., and D. R. Osborne. 1984. Predation by Atlantic cod (Gadus morhua) on short-finned squid (Illex illecebrosus) off eastern Newfoundland and in the northeastern Gulf of St. Lawrence. NAFO SCR Doc. 84/108, Serial No. N905. 16 p.

Murphy, E. F. 1996. Corrections to the stratification scheme in 3Ps. NAFO SCR Doc. 96/55. Serial No. N2731. 11 p.

Pinhorn, A. T. 1969. Fishery and biology of Atlantic cod (Gadus morhua) off the southwest coast of Newfoundland. J. Fish. Res. Board Can. 26: 3133-3164.

Shelton, P. A., and G. R. Lilly. 1995. Factors influencing weight at age of cod off eastern Newfoundland (NAFO Divisions 2J+3KL). ICES C.M.1995/P:14. 29 p.

Shelton, P. A., G. R. Lilly, and E. Colbourne. 1996. Patterns in the annual weight increment for 2J3KL cod and possible prediction for stock projection. NAFO SCR Doc. 96/47. Serial No. N2722. 23 p.

Smith, S. J., and G. D. Somerton. 1981. STRAP: A user-oriented computer analysis system for groundfish research trawl survey data. Can. Tech. Rep. Fish. Aquat. Sci. 1030: iv + 66 p.

Taggart, C. T., J. Anderson, C. Bishop, E. Colbourne, J. Hutchings, G. Lilly, J. Morgan, E. Murphy, R. Myers, G. Rose and P. Shelton. 1994. Overview of cod stocks, biology, and environment in the northwest Atlantic region of Newfoundland, with emphasis on northern cod. ICES mar. Sci. Symp. 198: 140-157.

Table 1. Selected data for bottom-trawl surveys in Subdivision 3Ps in winter-spring 1972-1996.

Year	Ship/trip	No. of stations	Dates of fishing		
			first	median	last
1972	ATC 197	45	21-Mar	26-Mar	29-Mar
1973	ATC 207	55	16-Mar	19-Mar	22-Mar
1974	ATC 221	79	20-Apr	24-Apr	30-Apr
1975	ATC 234	62	03-Jun	06-Jun	12-Jun
1976	ATC 247	69	12-May	15-May	20-May
1977	ATC 261	101	16-Apr	20-Apr	25-Apr
1978	ATC 273	44	23-Feb	25-Feb	28-Feb
1979	ATC 287	79	20-Feb	25-Feb	05-Mar
1980	ATC 302	81	20-Mar	29-Mar	02-Apr
1981	ATC 316	69	09-Mar	14-Mar	26-Mar
1982	ATC 330	92	29-May	04-Jun	08-Jun
1983	AN 9	164	23-Apr	01-May	08-May
1984	AN 26	93	10-Apr	14-Apr	17-Apr
1985	WT 26	109	08-Mar	13-Mar	25-Mar
1986	WT 45	136	06-Mar	15-Mar	23-Mar
1987	WT 55,56	130	13-Feb	09-Mar	22-Mar
1988	WT 68	146	27-Jan	07-Feb	14-Feb
1989	WT 81	146	01-Feb	09-Feb	16-Feb
1990	WT 91	108	01-Feb	09-Feb	19-Feb
1991	WT 103	158	02-Feb	10-Feb	20-Feb
1992	WT 118	137	06-Feb	15-Feb	24-Feb
1993[a]	WT 133	136	06-Feb	13-Feb	23-Feb
1993	WT 135	130	02-Apr	13-Apr	20-Apr
1994	WT 150,151	166	06-Apr	16-Apr	26-Apr
1995	WT 166,167	161	04-Apr	18-Apr	28-Apr
1996	WT 186,187	148	10-Apr	24-Apr	01-May
Total		2844			

[a] This survey is not considered to be part of the time-series. The survey time was changed to April to reduce the chances of catching cod from the 3Pn4RS stock.

Table 2. Instructions for sampling cod during bottom-trawl surveys in Subdivision 3Ps in 1972-1996. The instructions were extracted from unpublished trip reports available in the library of the Northwest Atlantic Fisheries Centre, St. John's, NF. In each of the sample descriptions, the numbers in parentheses are stratum numbers.

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1972	ATC 197	For the Subdivision, collect otoliths from cod < 32 cm; 5 per 3-cm group cod 33-62 cm; 15 per 3-cm group cod 63-101 cm; 30 per 3-cm group cod 102-116 cm; 15 per 3-cm group cod >116 cm; 5 per 3-cm group	
1973	ATC 207	As in 1972	
1974	ATC 221	As in 1972	
1975	ATC 234	As in 1972, except for cod 33-62 cm; 30 per 3-cm group	
1976	ATC 247	For the Subdivision, collect otoliths from 25 specimens per 3-cm group	
1977	ATC 261	As in 1976	
1978	ATC 273	As in 1976	For the Subdivision, freeze 5 specimens per 3-cm group
1979	ATC 287	As in 1976	As in 1978
1980	ATC 302	For the Subdivision, collect otoliths from 25-30 specimens per 3-cm group	As in 1978
1981	ATC 316	As in 1976	As in 1978
1982	ATC 330	As in 1976	Instructions not recorded, but sample obtained
1983	AN 9	As in 1976	As in 1978
1984	AN 26	As in 1976	As in 1978

(cont'd)

Table 2 (cont'd)

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1985	WT 26	For each of two samples, collect otoliths from 25 specimens per 3-cm group. Samples are: (1) Burgeo Bank (306-309) (2) St. Pierre Bank (all other strata, but excluding 714-716) For each sampled fish, also obtain: volume of liver volume of gonad	For each of two samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-312) (2) Halibut Channel (315, 318, 319)
1986	WT 45	As in 1985	As in 1985
1987	WT 55, 56	As in 1985	For each of two samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-314) (2) Burgeo Bank (306-309)
1988	WT 68	For the Subdivision, collect otoliths from 25 specimens per 3-cm group For each sampled fish, also obtain: volume of liver volume of gonad	As in 1987
1989	WT 81	As in 1988	For each of three samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-314) (2) Burgeo Bank (306-309) (3) Green Bank - Halibut Channel (east of 55010' W)
1990	WT 91	For the Subdivision, collect otoliths from 25 specimens per 3-cm group For each sampled fish, also obtain: round weight gutted weight weight of liver (volume if liver <100 g) weight of gonad (volume if gonad <100 g)	As in 1989

(cont'd)

Table 2 (cont'd)

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1991	WT 103	For the Subdivision, collect otoliths from 25 specimens per 3-cm group For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	As in 1989, except that in addition ***determine round weight at sea***
1992	WT 118	As in 1991	As in 1991
1993	WT 133 (February)	As in 1991	As in 1991
	WT 135 (April)	For the Subdivision, collect otoliths from 10 specimens per 3-cm group For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	For each of four samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-314, 705, 713) (2) Burgeo Bank (306-309, 714-716) (3) Green Bank - Halibut Channel (318, 319, 707-709) (4) Remaining strata (315-317, 320-326, 706, 711, 712) Determine round weights at sea
1994	WT 150, 151	For the Subdivision, collect otoliths from 2 specimens per cm For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	For each of five samples, freeze 2 specimens per cm Samples are: (1) Northwest St. Pierre Bank (310-314, 705, 713) (2) Burgeo Bank (306-309, 714-716) (3) Green Bank - Halibut Channel (318, 319, 325, 326, 707-710) (4) Placentia Bay (779-783) (5) Remaining strata (315-317, 320-324, 706, 711, 712) Determine round weights at sea
1995	WT 166, 167	As in 1994 (However, instructions for WT. 166 specified 10 specimens per cm, whereas instructions for WT. 167specified 2 per cm)	As in 1994 (Areas specified in instructions for WT. 167, but not for WT. 166)
1996	WT 186, 187	As in 1994	As in 1994

Table 3. Sampling of cod caught during bottom-trawl surveys in Subdivision 3Ps in 1972-1996. Number of aged fish for which there are also records of length, body weight and liver size (weight or volume).

		Body weight		Liver		
Year	Length	Round	Gutted	Weight	Volume[a]	Total
1972	427					
1973	382					
1974	400					
1975	611					
1976	677					
1977	548					
1978	372	108	108	107		107
1979	586	143	143	143		143
1980	620	162	162	162		162
1981	591	148	148	148		148
1982	727	154	154	154		154
1983	820	198	189	189		189
1984	581	140	140	140		140
1985	715	84	84	84	631	715
1986	910	139	139	139	773	912
1987	1004	232	232	232	769	1001
1988	909	234	234	234	673	907
1989	838	335	335	335	501	836
1990	582	581	580	253	328	581
1991	762	763	759	759		759
1992	553	554	552	554		554
1993	499	498	498	498		498
1994	578	578	572	577		577
1995	595	595	586	594		594
1996	841	841	809	810		810
Total	16128	6487	6424	6112	3675	9787

[a] Instances where liver volume was measured but not liver weight.

Table 4. Sampling of cod caught during bottom-trawl surveys in Subdivision 3Ps in 1972-1996. Number of fish for which there are records for age and length, by age and year.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total
1	3	8	11	25	15	1		13	3	2	25	24	1	2	1	6	3	3		8					55	209
2	16	20	21	37	126	21	24	24	106	30	119	59	19	35	29	27	61	39	9	71	12		18	3	79	1005
3	24	28	38	101	122	137	22	32	85	122	73	103	32	75	48	61	93	96	90	69	100	45	41	31	144	1812
4	62	44	35	117	167	101	119	68	54	75	139	48	63	94	120	89	91	131	118	112	52	119	103	42	121	2284
5	40	68	41	88	103	117	71	158	94	62	70	117	48	107	162	198	63	81	85	111	108	66	174	105	43	2380
6	32	19	60	82	50	75	45	101	126	83	44	56	171	71	189	181	109	68	56	79	93	96	61	183	120	2250
7	75	71	40	78	32	31	31	89	47	103	85	26	66	101	98	141	111	134	47	65	74	81	86	57	184	1953
8	72	34	58	31	33	15	23	51	49	34	103	67	32	48	97	83	89	87	60	51	40	28	48	73	37	1343
9	35	48	36	23	10	23	12	21	14	42	36	132	41	29	59	70	64	52	38	58	23	16	14	51	33	980
10	22	17	28	15	6	9	11	17	12	14	13	76	65	33	21	33	55	34	27	53	26	10	11	21	12	641
11	9	4	7	6	6	2	5	5	10	4	8	49	16	35	20	23	51	42	17	35	11	18	6	12	11	412
12	6	5	6	2	2	4	2	2	11	6	3	20	12	39	24	21	35	17	12	16	7	8	6	2	2	270
13	3	1	4	3		6	2	2	4	5	2	10	5	19	15	21	24	14	8	10	1	3	3	6		171
14	7	2	6			1		3		3	2	9	3	11	11	17	22	7	7	6	1	5	4	6		133
15	3	1	1	1	2	2	2		2	1	3	7		3	7	6	17	12	1	7	4	2		2		86
16	5	3	3						2	2	2	6	3	3	5	7	15	7	4	5	1	1	2			76
17	7	3	2	1	1		1		1	1		1		5	3	6	2	6	1	3		1	1			46
18	3	5	1		1	1						3	3	2		5	1	3	1	2						31
19	1		1		1		1					2				2	1	2	1	1						13
20	1			1		2				2		2			1	2	2	2								15
21	1											2	1	2		2										8
22			1				1							1		1										4
23												1				1								1		3
24		1																1								2
Total	427	382	400	611	677	548	372	586	620	591	727	820	581	715	910	1003	909	838	582	762	553	499	578	595	841	16127

Table 5. Sampling of cod caught during bottom-trawl surveys in Subdivision 3Ps in 1978-1996. Number of fish for which there are records for age and round weight, by age and year.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total
1		7	3		1	9								8					55	83
2	12	13	14	7	24	12	6		7		13	11	9	71	12		18	3	79	311
3	9	12	21	26	13	22	12	10	10	18	20	43	90	69	100	45	41	31	144	736
4	27	19	7	14	20	12	19	18	13	26	22	47	118	113	53	119	103	42	121	913
5	17	28	20	13	8	17	8	18	26	34	22	35	85	111	108	66	174	105	43	938
6	10	16	21	12	5	10	24	10	29	24	22	23	56	79	93	95	61	183	120	893
7	11	22	18	20	14	3	9	16	16	29	30	46	47	65	74	81	86	57	184	828
8	5	15	25	7	27	9	5	7	7	17	23	43	59	51	40	28	48	73	37	526
9	6	4	9	21	14	31	8	3	5	27	11	24	38	58	23	16	14	51	33	396
10	5	6	4	7	10	21	20	1	6	21	13	15	27	53	26	10	11	21	12	289
11	3	1	7	4	7	12	8		3	11	14	16	17	35	11	18	6	12	11	196
12	1		7	3	3	8	10	1	8	10	15	6	12	16	7	8	6	2	2	125
13			3	5	1	5	2		3	8	8	7	8	10	1	3	3	6		73
14				3	2	8	2		3	3	7	2	7	6	1	5	4	6		59
15			2	1	3	6			1		5	5	1	7	4	2		2		39
16			1	2	2	5	3		2	1	6	2	4	5	1	1	2			37
17				1		1				1	1	3	1	3		1	1			13
18						3	3			1	1	3	1	2						14
19	1					1				1		2	1	1						7
20				2		1					1	1								5
21						1	1													2
22	1																			1
23						1												1		2
24												1								1
Total	108	143	162	148	154	198	140	84	139	232	234	335	581	763	554	498	578	595	841	6487

Table 6. Mean length-at-age (cm) of cod sampled during resource assessment bottom-trawl surveys in Subdivision 3Ps in 1972-1996.

Age	1972	1973	1974	1975	1976	1977
1	14.0	11.6	12.2	12.7	13.2	11.0
2	23.2	22.6	21.7	23.1	22.8	20.3
3	31.5	31.7	33.4	35.3	35.4	31.7
4	41.0	39.3	43.0	44.4	48.2	43.2
5	51.9	50.1	50.8	55.4	57.4	55.5
6	58.5	56.6	55.6	61.0	64.6	63.6
7	63.0	62.1	63.5	66.5	68.1	74.0
8	74.1	66.1	71.1	74.3	71.8	75.2
9	81.8	68.4	69.4	74.2	78.4	88.0
10	90.4	81.1	79.3	75.2	81.7	83.8
11	95.0	86.2	93.4	76.2	94.7	77.6
12	88.3	87.1	95.6	107.2	110.5	87.9

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1		10.8	14.6	14.6	13.2	10.3	12.0		11.0	10.7	9.2	12.0		9.5					12.6
2	19.6	22.1	21.0	22.4	22.0	20.2	19.2	17.9	18.7	19.9	19.7	19.2	20.0	19.2	20.6		19.1	21.2	20.6
3	28.0	32.9	28.4	32.3	33.3	31.2	30.6	29.0	26.8	29.5	29.0	30.1	29.9	29.6	30.5	30.7	32.3	30.0	30.0
4	35.9	42.6	42.9	44.3	44.9	43.0	42.1	40.3	40.2	39.5	40.8	41.6	40.0	38.7	40.9	41.4	39.4	41.3	38.6
5	48.0	47.5	50.6	50.4	53.4	52.6	51.8	51.0	48.5	48.0	47.5	47.8	48.1	46.9	47.1	48.4	48.0	50.2	44.1
6	59.0	55.7	58.2	58.6	59.3	57.8	60.6	60.0	55.5	53.9	56.2	56.0	53.7	53.3	55.1	52.9	50.1	56.4	52.9
7	65.6	70.4	71.1	63.2	66.4	65.4	66.2	66.4	62.3	60.9	62.0	63.8	58.7	57.5	61.2	61.9	53.6	58.5	60.9
8	70.1	76.3	84.8	70.1	70.1	71.4	70.6	74.1	71.7	67.0	66.7	71.8	62.2	62.1	62.3	69.5	59.2	57.9	61.1
9	84.1	85.8	94.9	72.6	75.6	73.3	75.6	74.3	76.4	76.9	74.6	75.6	70.1	67.8	66.0	77.2	68.5	62.9	63.3
10	86.3	95.3	98.0	83.2	90.6	79.4	78.9	79.4	82.8	86.7	79.6	84.4	72.6	73.6	73.5	80.2	87.4	79.9	76.7
11	88.3	94.3	97.2	97.6	98.7	89.6	84.2	89.1	91.7	84.5	80.0	88.6	79.4	74.1	83.6	91.6	75.2	81.2	74.7
12	79.3	116.0	106.6	90.2	104.6	94.1	98.2	93.0	93.9	90.3	87.5	96.9	86.7	77.6	81.9	88.4	90.3	83.6	86.1

Table 7. Mean weight-at-age (kg) of cod sampled during resource assessment bottom-trawl surveys in Subdivision 3Ps in 1978-1996.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1		0.011	0.027		0.040	0.010								0.012					0.018
2	0.057	0.070	0.068	0.080	0.103	0.068	0.073		0.045		0.057	0.060	0.062	0.054	0.064		0.053	0.062	0.073
3	0.177	0.250	0.147	0.265	0.420	0.231	0.268	0.214	0.168	0.248	0.193	0.239	0.207	0.218	0.230	0.214	0.254	0.213	0.219
4	0.396	0.625	0.618	0.704	0.829	0.718	0.632	0.505	0.462	0.538	0.582	0.613	0.538	0.472	0.574	0.564	0.468	0.537	0.462
5	0.979	0.893	1.005	1.079	1.299	1.301	1.212	1.039	0.904	0.950	0.915	0.901	0.957	0.885	0.865	0.912	0.903	1.013	0.673
6	1.735	1.603	1.634	1.673	1.539	1.652	1.853	1.566	1.332	1.273	1.494	1.331	1.351	1.322	1.461	1.160	1.035	1.513	1.283
7	2.368	3.082	3.457	2.081	2.555	1.861	2.790	2.279	2.384	1.900	2.214	2.361	1.623	1.718	2.046	1.963	1.231	1.716	2.009
8	3.192	4.896	5.791	3.496	2.611	3.555	3.828	3.206	3.337	2.244	2.423	3.778	2.185	2.281	2.246	2.866	1.832	1.582	2.084
9	4.676	5.798	8.459	4.890	4.007	4.042	4.225	3.143	5.023	4.303	3.943	4.505	3.060	3.043	2.761	4.142	2.917	2.208	2.136
10	5.711	7.102	8.332	7.591	6.441	4.896	5.007	3.760	4.654	6.946	4.839	5.820	3.830	3.952	4.003	4.452	6.370	4.797	4.464
11	4.901	9.030	9.085	8.374	8.885	8.848	7.606		8.633	8.017	4.261	8.285	4.934	4.083	5.805	7.333	4.393	5.459	3.897
12	5.760		10.158	11.463	13.068	10.270	9.818	3.970	8.867	6.594	9.103	9.061	7.365	4.937	5.301	6.927	6.748	5.544	6.793

Table 8. Growth of cod in Subdivision 3Ps as determined from sampling conducted during winter-spring bottom-trawl surveys in 1978-1996. Results of the general linear model in which age effects were fitted to the log transformed annual mean length increment data for ages 2-6. (The length increment for age 2 is the increase in mean length from age 2 in year t to age 3 in year t+1).

General Linear Models Procedure (SAS)

Class Level Information

Class	Levels	Values
AGE	5	2 3 4 5 6

Number of observations in data set = 119

Dependent Variable: LMLINCR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	8.1723991	2.0430998	10.24	0.0001
Error	114	22.7493074	0.1995553		
Corrected Total	118	30.9217065			

R-Square	C.V.	Root MSE	LMLINCR Mean
0.264293	21.94277	0.4467	2.0358

Source	DF	Type I SS	Mean Square	F Value	Pr > F
AGE	4	8.1723991	2.0430998	10.24	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	4	8.1723991	2.0430998	10.24	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		1.667084586 B	18.28	0.0001	0.09118555
AGE	2	0.638129486 B	4.90	0.0001	0.13035001
	3	0.659219686 B	5.11	0.0001	0.12895585
	4	0.410009655 B	3.18	0.0019	0.12895585
	5	0.147563839 B	1.14	0.2549	0.12895585
	6	0.000000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

Table 9. Mean gutted condition at age of cod caught during winter-spring bottom-trawl surveys in Subdivision 3Ps.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1		0.954	0.531		0.611									1.704					0.771
2	0.702	0.629	0.595	0.599	0.660	0.632	0.651		0.699		0.648	0.681	0.623	0.641	0.603		0.637	0.630	0.698
3	0.745	0.678	0.620	0.718	0.731	0.742	0.734	0.706	0.698	0.736	0.713	0.725	0.679	0.704	0.711	0.659	0.673	0.691	0.706
4	0.733	0.715	0.680	0.748	0.740	0.777	0.735	0.704	0.704	0.725	0.739	0.739	0.726	0.711	0.733	0.711	0.679	0.689	0.710
5	0.753	0.702	0.703	0.724	0.722	0.766	0.703	0.680	0.733	0.735	0.731	0.734	0.744	0.719	0.716	0.695	0.707	0.702	0.695
6	0.730	0.712	0.709	0.745	0.676	0.794	0.711	0.714	0.709	0.717	0.731	0.741	0.743	0.744	0.733	0.664	0.678	0.708	0.713
7	0.744	0.699	0.724	0.729	0.699	0.737	0.728	0.739	0.721	0.735	0.736	0.748	0.735	0.745	0.735	0.681	0.658	0.704	0.715
8	0.716	0.775	0.734	0.763	0.690	0.725	0.726	0.714	0.717	0.720	0.736	0.780	0.726	0.734	0.727	0.700	0.678	0.665	0.722
9	0.737	0.749	0.765	0.748	0.731	0.744	0.730	0.733	0.676	0.768	0.777	0.793	0.735	0.756	0.733	0.744	0.685	0.702	0.671
10	0.793	0.803	0.715	0.810	0.751	0.793	0.741	0.740	0.719	0.798	0.789	0.834	0.762	0.777	0.735	0.704	0.738	0.726	0.758
11	0.681	0.648	0.784	0.790	0.758	0.819	0.800		0.798	0.787	0.783	0.827	0.794	0.763	0.798	0.753	0.683	0.750	0.724
12	0.725		0.759	0.843	0.833	0.865	0.834	0.681	0.789	0.793	0.813	0.852	0.792	0.790	0.747	0.755	0.717	0.751	0.760

Table 10. Mean liver index at age of cod caught during winter-spring bottom-trawl surveys in Subdivision 3Ps.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1		0.0931	0.0284		0.0204				0.0751	0.1098	0.1186	0.0595		0.1321					0.0657
2	0.0175	0.0142	0.0150	0.0118	0.0229	0.0247	0.0120	0.0238	0.0230	0.0304	0.0251	0.0279	0.0292	0.0249	0.0283		0.0319	0.0139	0.0251
3	0.0223	0.0160	0.0114	0.0146	0.0244	0.0280	0.0167	0.0168	0.0233	0.0230	0.0227	0.0215	0.0212	0.0207	0.0200	0.0107	0.0143	0.0125	0.0160
4	0.0203	0.0181	0.0143	0.0188	0.0228	0.0323	0.0179	0.0175	0.0195	0.0220	0.0275	0.0266	0.0293	0.0289	0.0240	0.0154	0.0140	0.0130	0.0163
5	0.0227	0.0194	0.0189	0.0169	0.0230	0.0275	0.0142	0.0174	0.0214	0.0238	0.0281	0.0267	0.0335	0.0286	0.0315	0.0179	0.0201	0.0207	0.0168
6	0.0253	0.0218	0.0204	0.0194	0.0163	0.0348	0.0144	0.0219	0.0231	0.0244	0.0279	0.0300	0.0358	0.0315	0.0308	0.0186	0.0223	0.0200	0.0201
7	0.0256	0.0293	0.0262	0.0213	0.0207	0.0277	0.0195	0.0215	0.0238	0.0276	0.0280	0.0304	0.0376	0.0360	0.0263	0.0183	0.0168	0.0212	0.0219
8	0.0323	0.0359	0.0370	0.0322	0.0203	0.0303	0.0191	0.0234	0.0267	0.0289	0.0312	0.0339	0.0334	0.0338	0.0367	0.0208	0.0211	0.0179	0.0231
9	0.0284	0.0319	0.0381	0.0418	0.0225	0.0326	0.0188	0.0268	0.0301	0.0352	0.0356	0.0403	0.0349	0.0381	0.0387	0.0279	0.0205	0.0189	0.0194
10	0.0326	0.0362	0.0328	0.0470	0.0258	0.0327	0.0328	0.0301	0.0383	0.0446	0.0439	0.0432	0.0397	0.0409	0.0384	0.0206	0.0402	0.0266	0.0303
11	0.0256	0.0276	0.0381	0.0277	0.0356	0.0445	0.0306	0.0405	0.0425	0.0384	0.0496	0.0519	0.0471	0.0417	0.0472	0.0387	0.0227	0.0343	0.0314
12	0.0379		0.0385	0.0415	0.0539	0.0462	0.0451	0.0435	0.0465	0.0504	0.0545	0.0657	0.0477	0.0380	0.0377	0.0317	0.0326	0.0247	0.0202

Table 11. Details of 126 samples collected for determination of body weight during the sentinel surveys in Subdivision 3Ps in 1995. Communities are arranged from west (top) to east. The length information pertains to the whole sample.

			Length			Number of weight records			
Community	Gear	Date	Minimum	Median	Maximum	Round	Gutted	Liver	Gonad
Ramea	LT	27-Feb	40	55.0	91	24	24	24	24
	LT	14-Mar	43	57.5	80	40	40	40	40
	LT	04-Apr	40	57.0	76	39	39	39	39
	LT	12-Apr	41	56.5	84	34	34	34	34
	LT	26-Apr	37	53.5	66	48	48	48	48
	LT	10-May	41	56.0	82	54	53	54	54
	LT	24-May	42	60.0	101	57	57	57	57
	LT	07-Jun	43	58.0	78	39	39	39	39
	LT	03-Oct	36	59.5	78	24	24	24	24
	LT	14-Nov	39	54.5	72	25	26	26	26
	LT	30-Nov	42	57.0	73	25	25	25	25
Francois	LT	27-Feb	40	54.5	66	22	22	22	22
	LT	21-Mar	29	50.0	75	21	21	21	21
	LT	11-Apr	38	58.0	77	29	29	29	29
	LT	25-Apr	38	54.5	77	32	32	32	32
	LT	10-May	44	58.0	88	37	37	37	37
	LT	24-May	41	57.0	74	37	37	37	37
	LT	06-Jun	46	61.5	99	16	16	16	16
	LT	25-Sep	31	53.5	86	28	28	28	28
	LT	18-Nov	35	55.0	79	30	31	30	31
	LT	08-Dec	34	55.5	71	26	26	26	26
Seal Cove	LT	07-Mar	42	54.0	75	27	27	27	27
	LT	21-Mar	45	57.5	77	28	28	28	27
	LT	03-Apr	45	57.0	64	22	22	22	22
	LT	20-Apr	38	50.0	62	25	25	24	25
	LT	01-May	41	53.5	67	34	34	34	34
	LT	16-May	43	53.0	76	23	23	23	23
	LT	01-Jun	44	57.5	79	12	12	12	12
	LT	13-Jun	44	57.0	69	26	26	26	26
	LT	26-Jun	48	64.0	85	10	10	10	10
	LT	04-Oct	47	58.0	75	23	23	23	23
	LT	24-Oct	45	56.0	80	21	21	20	21
	LT	07-Nov	43	55.5	70	22	22	22	22
	LT	22-Nov	38	55.5	71	24	24	23	24
	LT	05-Dec	46	58.0	74	25	25	25	25
Harbour Breton	LT	07-Mar	42	57.0	85	11	11	11	11
	LT	21-Mar	29	35.0	69	5	5	5	5
	LT	24-Apr	32	50.0	74	45	45	45	45
	LT	12-May	33	59.0	86	32	31	32	32

Table 11. (cont'd)

Community	Gear	Date	Length			Number of weight records			
			Minimum	Median	Maximum	Round	Gutted	Liver	Gonad
Harbour Breton	LT	26-May	36	56.0	89	43	43	42	43
(cont'd)	LT	09-Jun	42	60.5	94	46	46	46	46
	LT	21-Jun	39	55.5	81	50	50	50	50
	LT	03-Jul	44	59.0	83	25	25	25	25
	LT	25-Oct	31	39.0	46	44	44	44	44
	LT	01-Nov	18	33.5	43	20	20	20	20
	LT	07-Nov	31	37.0	41	33	34	34	34
	LT	29-Nov	42	61.0	97	58	58	58	58
	LT	29-Dec	46	54.5	85	20	20	20	20
Rencontre East	LT	19-Feb	37	50.5	62	24	24	24	24
	LT	08-Mar	35	50.0	70	16	16	16	16
	LT	20-Mar	38	52.0	73	31	31	0	0
	LT	03-Apr	34	53.0	87	57	57	16	16
	LT	17-Apr	32	43.5	68	10	10	0	0
	LT	01-May	38	52.5	70	46	46	0	0
	LT	15-May	33	50.0	70	35	35	0	0
	LT	29-May	43	55.0	85	30	30	0	0
	LT	12-Jun	43	59.0	85	11	11	11	11
	LT	30-Oct	30	52.0	93	29	29	29	29
	LT	13-Nov	34	56.0	75	23	23	23	23
	LT	27-Nov	38	57.5	84	28	28	27	28
	LT	11-Dec	35	54.0	77	31	31	31	31
	LT	26-Dec	31	54.5	104	36	36	36	36
Lords Cove	GN	04-Oct	55	66.0	81	21	21	21	21
	LT	18-Oct	47	61.0	78	29	29	29	29
Red Harbour	LT	02-Oct	32	55.5	82	34	34	34	34
	LT	20-Oct	33	53.0	80	25	25	25	25
Monkstown	GN	16-Mar	61	68.0	75	3	3	3	3
	GN	13-Apr	64	66.5	72	4	4	4	4
	GN	29-Apr	59	66.0	70	15	15	15	15
	GN	12-May	58	63.0	77	46	46	46	46
	GN	31-May	54	62.0	88	34	34	34	34
	GN	07-Jun	54	60.0	84	14	14	14	15
	GN	19-Jun	51	59.0	71	12	12	12	12
	GN	06-Jul	50	60.0	84	12	12	12	12
	GN	13-Sep	54	62.5	77	16	16	16	16
	GN	18-Oct	51	64.5	90	18	18	18	18

Table 11. (cont'd)

Community	Gear	Date	Length			Number of weight records			
			Minimum	Median	Maximum	Round	Gutted	Liver	Gonad
North Harbour	GN	07-Mar	54	67.0	86	40	40	40	40
	GN	23-Mar	57	63.0	75	9	10	10	10
	GN	03-May	55	64.0	73	35	36	36	36
	GN	06-Jun	53	63.0	86	24	24	24	24
	GN	04-Jul	51	60.0	71	32	32	32	32
	GN	14-Nov	40	63.0	83	53	53	53	53
	GN	22-Nov	50	59.5	82	36	36	36	36
	GN	13-Dec	40	64.5	83	34	34	34	34
Arnolds Cove	LT	08-Mar	47	47.0	47	1	1	1	1
	LT	11-May	48	54.5	65	16	16	15	16
	LT	30-Jun	47	56.0	76	6	6	6	6
	LT	18-Oct	65	68.0	71	2	2	2	2
	LT	08-Nov	70	70.5	71	2	2	2	2
	LT	21-Nov	47	55.5	64	2	2	2	2
	LT	06-Dec	64	65.5	67	2	2	2	2
	LT	21-Dec	51	54.5	58	2	2	2	2
Little Harbour	GN	06-Mar	62	62.0	62	1	1	1	1
	GN	08-Mar	73	73.0	73	0	0	1	1
	GN	21-Mar	61	64.5	68	2	2	2	2
	GN	22-Mar	65	65.0	65	1	1	1	1
	GN	23-Mar	62	62.0	67	2	2	2	2
	GN	02-May	35	67.0	85	42	42	42	43
	GN	16-May	59	67.0	83	25	25	25	25
	GN	30-May	56	66.0	72	9	9	9	9
	GN	13-Jun	44	64.0	85	34	36	35	36
	GN	27-Jun	55	65.0	90	37	37	37	37
	GN	27-Sep	40	67.5	84	12	12	12	12
	GN	20-Oct	53	67.5	78	20	20	20	20
	GN	31-Oct	54	66.0	82	19	19	19	19
	GN	15-Nov	55	68.0	83	19	19	19	19
	GN	30-Nov	54	66.0	76	15	15	15	15
	GN	14-Dec	40	63.0	78	23	23	23	23
Fox Harbour	GN	17-May	61	65.0	70	4	4	4	4
	GN	07-Jun	61	64.5	71	10	10	10	10
	GN	25-Jun	51	61.0	74	23	23	23	23
	GN	04-Jul	36	62.5	75	32	34	30	33
Placentia	GN	14-Mar	58	62.0	68	4	4	4	4
(Red Island/	LT	20-Oct	37	55.0	85	47	47	47	46
Clattice Hr.)	LT	15-Nov	35	59.0	78	30	30	30	30

Table 11. (cont'd)

Community	Gear	Date	Length			Number of weight records			
			Minimum	Median	Maximum	Round	Gutted	Liver	Gonad
St Brides	GN	03-May	59	59.0	59	1	1	1	1
	GN	26-May	43	43.0	43	1	1	1	1
	GN	31-May	58	58.0	58	1	1	1	1
	GN	01-Jun	61	62.5	64	2	2	2	2
	GN	05-Jun	53	57.5	63	6	6	6	6
	GN	06-Jun	58	62.0	67	3	3	3	3
	GN	07-Jun	67	68.0	69	2	2	2	2
	GN	19-Jun	58	62.0	70	3	3	3	3
	GN	21-Jun	57	61.5	69	9	10	10	10
	GN	19-Jul	53	61.5	74	16	16	16	16
	GN	17-Sep	57	66.0	81	10	10	10	10
Total						2892	2900	2698	2709

Table 12. Summary of stomach contents of cod sampled during the sentinel surveys in Subdivision 3Ps in 1995. The indices are percentages of occurrence (O), percentage weight (W) and mean partial fullness index (PFI).

	O(%)[a]	W(%)	PFI[b]
Invertebrata (misc)		0.12	+
Cnidaria		1.47	0.007
Mollusca		0.66	0.004
Polychaeta		1.48	0.011
Echinodermata			
Ophiuroidea		9.82	0.053
Others + misc.		0.99	0.004
Crustacea			
Hyperiidae	33.56	11.96	0.101
Gammaridea		0.25	0.002
Mysidacea		0.01	+
Euphausiacea		0.67	0.004
Natantia		3.10	0.022
Reptantia			
Chionoecetes opilio	5.27	7.31	0.027
Hyas spp.		8.67	0.037
Misc. + unid.		3.18	0.013
Others + unid.		0.03	+
Pisces			
Clupea harengus	0.28	2.49	0.010
Mallotus villosus	4.52	22.37	0.121
Gadus morhua	0.12	0.55	0.002
Sebastes sp.	1.34	5.30	0.015
Pleuronectidae		3.28	0.001
Others		1.22	0.005
Unidentified		5.04	0.020
Unidentified + misc.		2.15	0.012
Bait	6.44	7.86	0.049
Total			0.529
No. of stomachs	2545		
Percent empty	15.6		
Length: mean	58		
minimum	18		
maximum	104		

[a] Percentage occurrence is provided only for taxa not initially identified at a lower level.

[b] + indicates PFI < 0.0005

Table 13. Details of 119 stomach samples collected from 14 communities during the sentinel surveys in Subdivision 3Ps in 1995. Communities are arranged from west (top) to east. Values less than 0.005 are shown as missing.

Community	Gear	Date	No. of stomachs	Total fullness index	Partial fullness index							
					herring	capelin	redfish	flatfish	hyperiid amphipods	snow crabs	toad crabs	bait
Ramea	LT	27-Feb	22	.179								.106
	LT	14-Mar	37	.026								.005
	LT	04-Apr	35	.038		.001				.001		
	LT	12-Apr	28	.309					.001		.002	.134
	LT	26-Apr	44	.482			.080		.002	.038	.033	.067
	LT	10-May	46	.294		.011		.007	.038	.062	.017	.058
	LT	24-May	52	.273			.021	.007	.003	.013	.005	.064
	LT	07-Jun	36	.713		.034	.066		.301	.041	.087	.081
	LT	03-Oct	24	.403			.013	.015				.066
	LT	14-Nov	25	1.271			.041		.977			.091
	LT	30-Nov	25	.445			.014		.126			.082
Francois	LT	27-Feb	20	.084			.014					.029
	LT	21-Mar	18	.187			.078			.024		.025
	LT	11-Apr	23	.186					.001		.009	
	LT	25-Apr	27	.238					.006		.015	.148
	LT	10-May	32	.292			.044	.001	.013	.058	.009	.037
	LT	24-May	33	.348			.039		.060	.079	.022	.066
	LT	06-Jun	14	1.443					.428	.144	.047	.417
	LT	25-Sep	28	.557					.091	.001	.002	.086
	LT	18-Nov	31	1.435						.028	.027	.060
	LT	08-Dec	25	.273			.049		.025	.006	.018	
Seal Cove	LT	07-Mar	23	.133								.021
	LT	21-Mar	27	.027								.019
	LT	03-Apr	20	.142								.025
	LT	20-Apr	25	.160							.001	.062
	LT	01-May	31	.101			.007					.042
	LT	16-May	21	.105								.014

Table 13 (cont'd)

Community	Gear	Date	No. of stomachs	Total fullness index	Partial fullness index							
					herring	capelin	redfish	flatfish	hyperiid amphipods	snow crabs	toad crabs	bait
Seal Cove	LT	01-Jun	12	.354		.036	.079		.002			.097
(cont'd)	LT	13-Jun	25	.640		.038			.239	.005	.065	.181
	LT	26-Jun	9	.355					.102	.029	.032	
	LT	04-Oct	23	.421					.002		.016	.156
	LT	24-Oct	21	.478					.043	.071	.013	.179
	LT	07-Nov	11	.177					.136			
	LT	22-Nov	24	.312					.122			.059
	LT	05-Dec	25	.262					.008			.130
Harbour Breton	LT	07-Mar	10	.090							.013	
	LT	21-Mar	5	.126							.056	
	LT	24-Apr	37	.136					.004	.007	.007	.066
	LT	12-May	28	.452			.053	.040	.031	.003		
	LT	26-May	35	.692		.014	.075		.085	.038	.037	.154
	LT	09-Jun	41	.545		.017	.012		.257	.001	.043	.068
	LT	21-Jun	46	.477		.014			.256	.014	.025	.006
	LT	03-Jul	22	.604		.037			.153	.036	.134	.005
	LT	25-Oct	43	1.677					1.432		.023	.017
	LT	01-Nov	20	.372							.014	.049
	LT	07-Nov	34	.919					.598			.123
	LT	29-Nov	54	.454		.025	.020	.009	.019	.134		.032
	LT	29-Dec	20	.333					.006	.018	.024	.054
Rencontre	LT	19-Feb	23	.327					.096	.066		.142
	LT	08-Mar	16	.093					.037		.006	.033
	LT	03-Apr	14	.570					.286			.283
	LT	12-Jun	11	1.601	.490	.042			1.029	.026		
	LT	30-Oct	28	.730			.298		.008		.073	.145
	LT	13-Nov	23	.416					.010	.027	.006	.051
	LT	27-Nov	26	.394			.137		.019	.001	.013	.176

Table 13 (cont'd)

Community	Gear	Date	No. of stomachs	Total fullness index	Partial fullness index							
					herring	capelin	redfish	flatfish	hyperiid amphipods	snow crabs	toad crabs	bait
Rencontre	LT	11-Dec	29	.228					.002	.016		.084
(cont'd)	LT	26-Dec	35	.266			.027					.066
Lords Cove	GN	04-Oct	21	.597					.018	.017	.024	
	LT	18-Oct	29	.656				.003		.014	.277	.039
Red Harbour	LT	02-Oct	34	.418						.012	.146	.017
	LT	20-Oct	25	.622						.092	.033	
Monkstown	GN	16-Mar	3	.745					.024	.719		
	GN	13-Apr	4	.020		.007			.002			
	GN	29-Apr	15	.633	.582					.042		
	GN	12-May	46	.173		.024	.022	.005	.043	.024	.023	
	GN	31-May	30	.375		.074		.001	.093	.009	.010	
	GN	07-Jun	15	.964		.578	.013	.003	.140	.021	.053	
	GN	19-Jun	11	1.712		1.111			.222			
	GN	06-Jul	12	6.817		6.760			.053			
	GN	13-Sep	16	.336					.066		.048	
	GN	18-Oct	18	.680			.046	.030	.032	.170		
North Harbour	GN	07-Mar	39	.209		.024			.001	.143		
	GN	23-Mar	10	1.337	.847	.318			.016	.084		
	GN	03-May	36	.415				.089	.057	.065	.003	
	GN	06-Jun	23	.246				.008	.046	.012	.001	
	GN	04-Jul	31	.583		.336			.145	.014	.025	
	GN	14-Nov	53	.118				.008	.006		.001	
	GN	22-Nov	36	.065					.013	.007		
	GN	13-Dec	34	.095						.027		

Table 13 (cont'd)

Community	Gear	Date	No. of stomachs	Total fullness index	Partial fullness index							
					herring	capelin	redfish	flatfish	hyperiid amphipods	snow crabs	toad crabs	bait
Arnolds Cove	LT	08-Mar	1	.010								
	LT	11-May	12	.313					.007		.126	.143
	LT	30-Jun	6	.039					.005			.008
	LT	18-Oct	2	.115								
	LT	08-Nov	2	1.911					.039	1.520		
	LT	21-Nov	2	.192								
	LT	06-Dec	2	.038								
	LT	21-Dec	2	.405					.041			.351
Little Harbour	GN	06-Mar	1	.017					.004			
	GN	08-Mar	1	.026								
	GN	21-Mar	2	1.320	1.255							
	GN	22-Mar	1	.222		.222						
	GN	23-Mar	2	.000								
	GN	02-May	40	.335		.085		.088	.017	.052	.011	
	GN	16-May	25	.447		.061		.107	.051	.082	.059	
	GN	30-May	8	.718		.437			.178			
	GN	13-Jun	35	.375		.110		.071	.044	.028	.059	
	GN	27-Jun	34	.382		.178		.022	.062	.006	.004	
	GN	27-Sep	12	.537					.073	.219	.024	
	GN	20-Oct	20	.092					.034	.037	.001	
	GN	31-Oct	19	.260		.006			.139	.043	.016	
	GN	15-Nov	19	.664				.015	.357	.020		
	GN	30-Nov	15	.340			.023	.078	.030	.038		
	GN	14-Dec	23	.058					.011			
Fox Harbour	GN	17-May	4	.278						.057	.028	
	GN	07-Jun	10	.710		.079	.276		.064	.037		
	GN	25-Jun	22	1.806		1.433		.069	.102		.021	
	GN	04-Jul	31	.952		.627		.154	.025			

Table 13 (cont'd)

Community	Gear	Date	No. of stomachs	Total fullness index	Partial fullness index							
					herring	capelin	redfish	flatfish	hyperiid amphipods	snow crabs	toad crabs	bait
Placentia	LT	20-Oct	45	.857					.139	.069	.009	.105
	LT	15-Nov	30	1.107					.335	.030	.136	.324
St Brides	GN	26-May	1	.843		.453						
	GN	31-May	1	.410							.287	
	GN	01-Jun	2	.665					.004		.170	
	GN	05-Jun	6	.291					.107			
	GN	06-Jun	3	.211		.162						
	GN	07-Jun	2	.122					.002			
	GN	19-Jun	3	1.291		.948						
	GN	21-Jun	10	.429					.001			
	GN	19-Jul	16	6.634		6.603					.005	
	GN	17-Sep	10	.614							.247	
Total			2545									

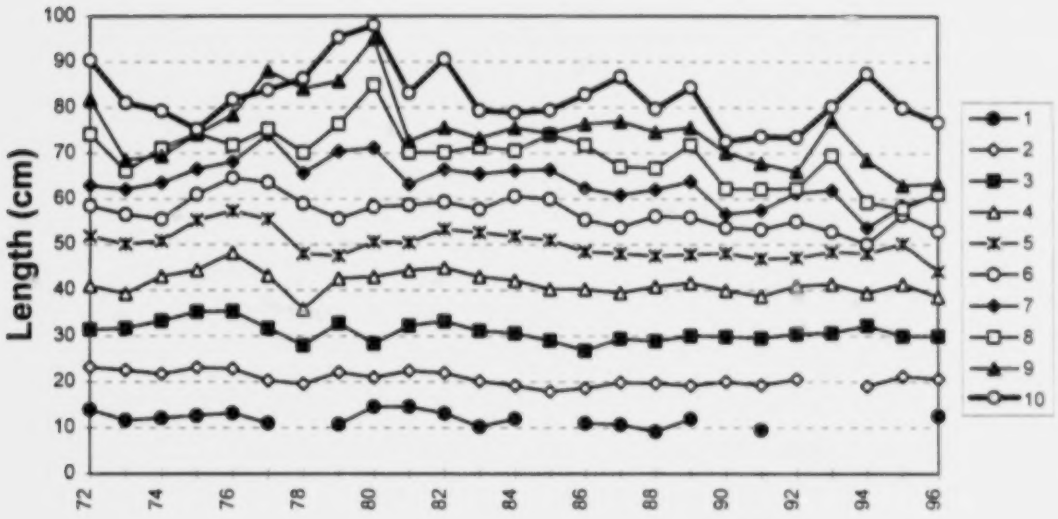

Fig. 1. Mean length at ages 1-10 of cod in Subdivision 3Ps in 1972-1996, as determined from sampling during bottom-trawl surveys in winter-spring.

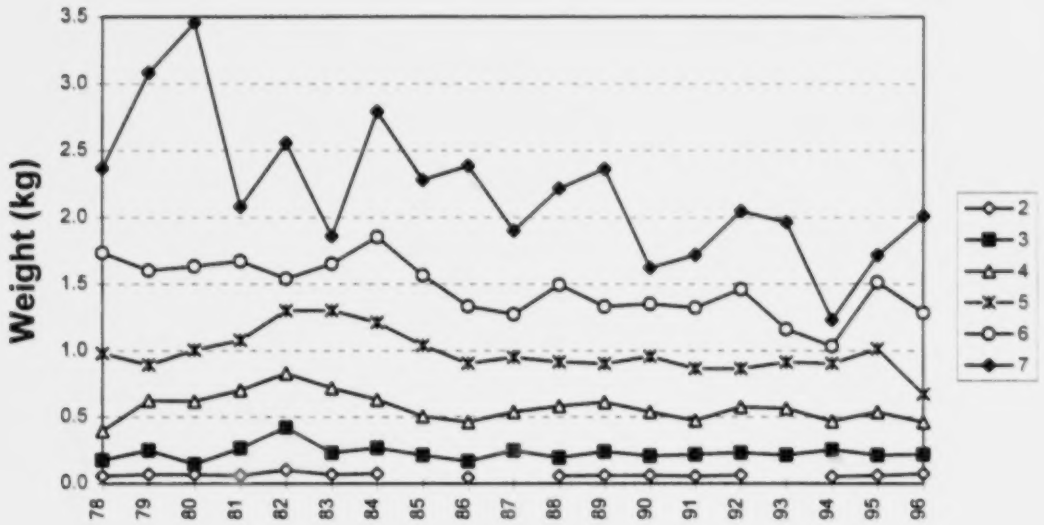

Fig. 2. Mean weight at ages 2-7 of cod in Subdivision 3Ps in 1978-1996, as determined from sampling during bottom-trawl surveys in winter-spring.

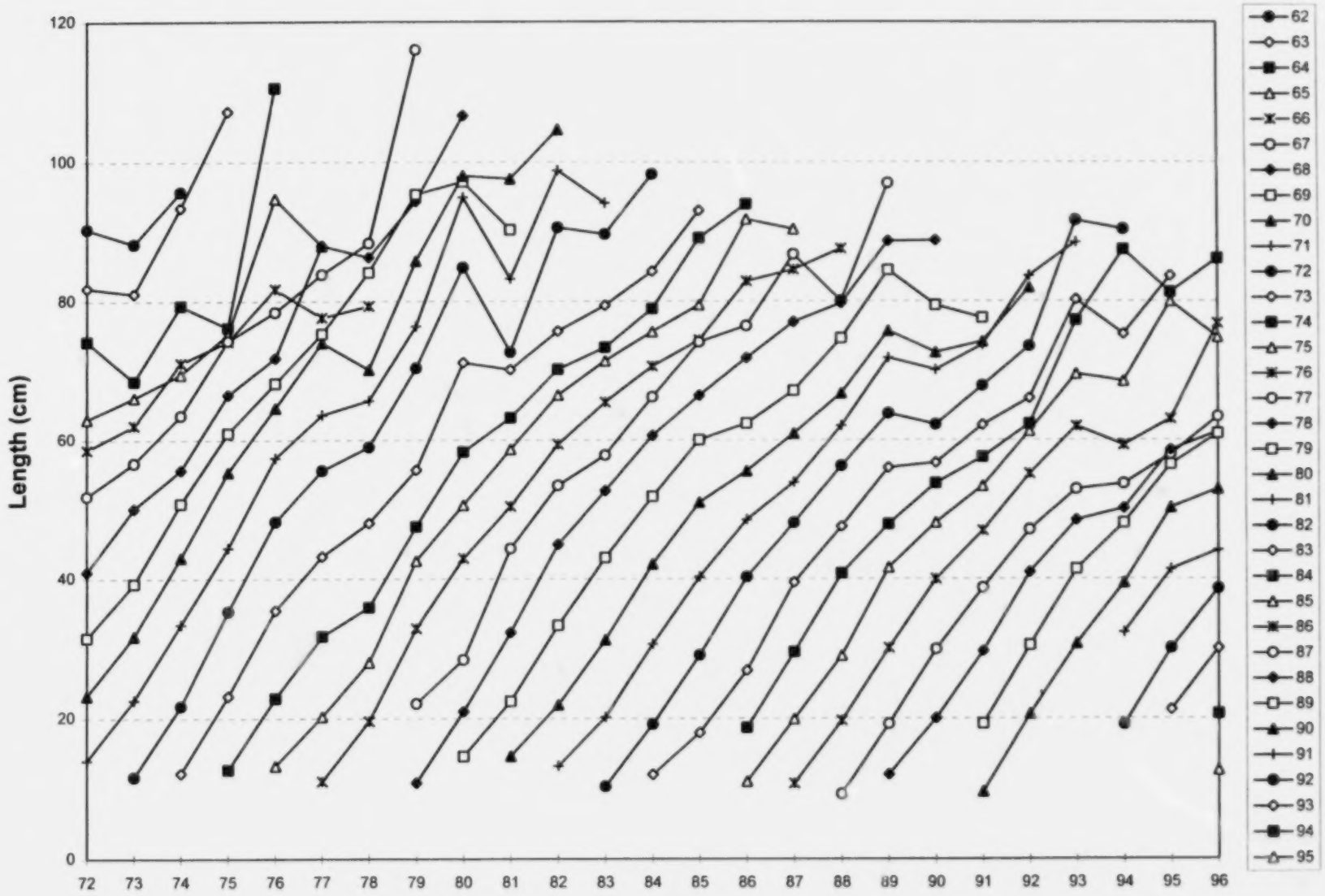

Fig. 3. Length (cm) at ages 1-12 of the 1962-1995 cohorts of Subdivision 3Ps cod, as determined from sampling during winter-spring bottom-trawl surveys.

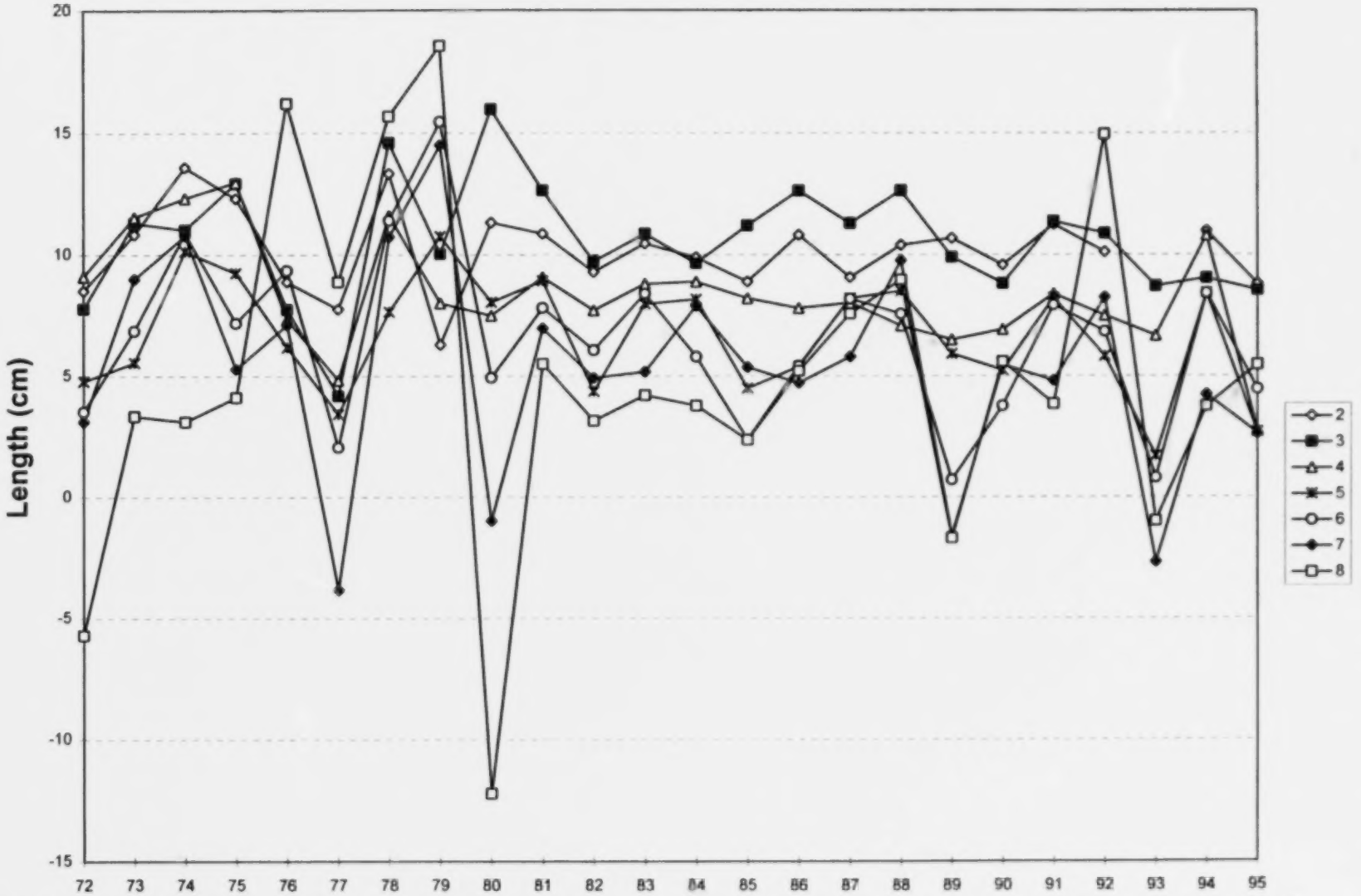

Fig. 4. Length increments (cm) for 3Ps cod of ages 2 to 8, as determined from sampling during winter-spring bottom-trawl surveys. The increment from year t to year t+1 is referenced to year t.

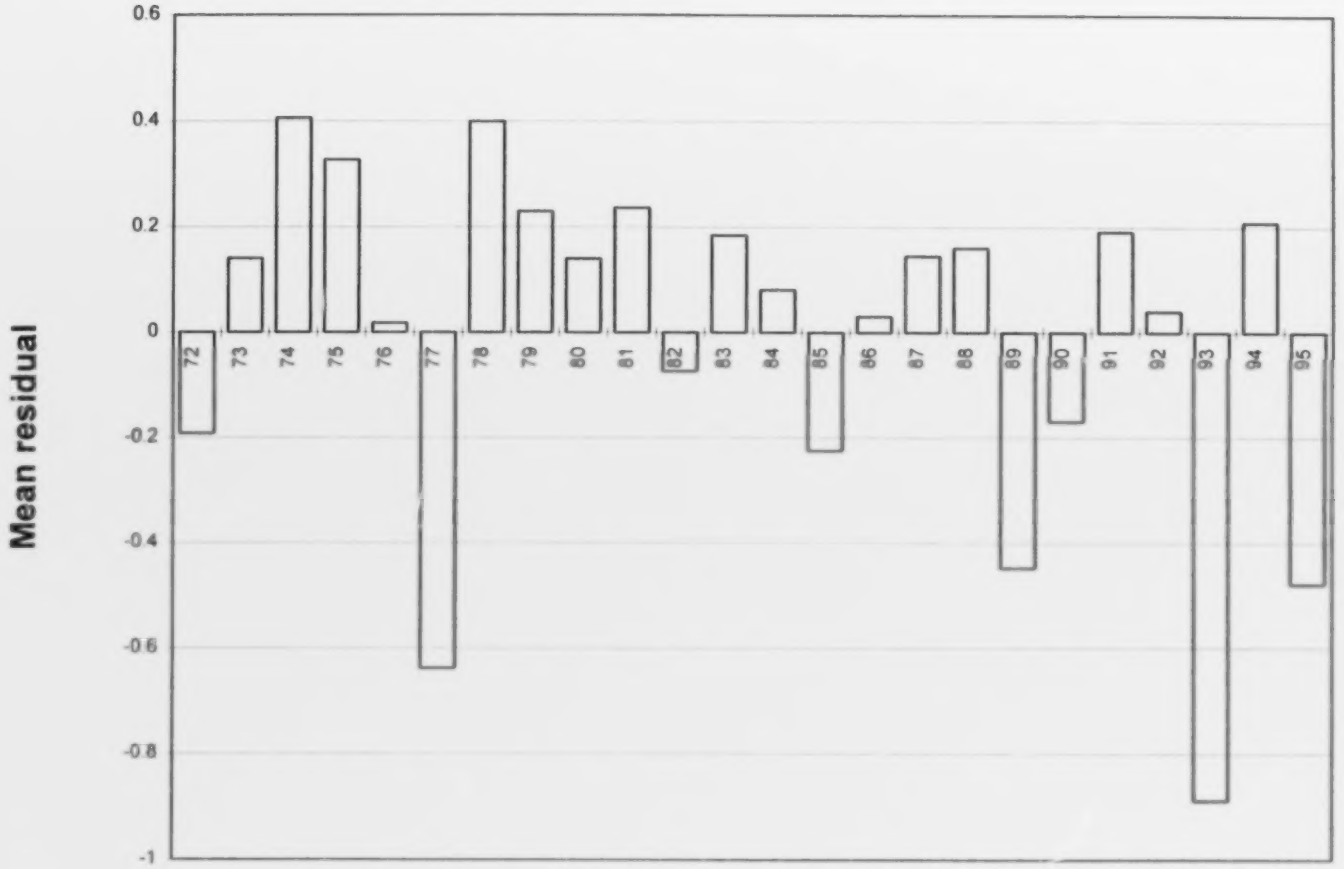

Fig. 5. Annual variability in the growth of cod in Subdivision 3Ps, as determined from sampling conducted during winter-spring bottom-trawl surveys. The plot shows annual residuals, averaged over ages 2-6, from the general linear model in which age effects were fitted to the log transformed annual mean length increment data (see Table 8).

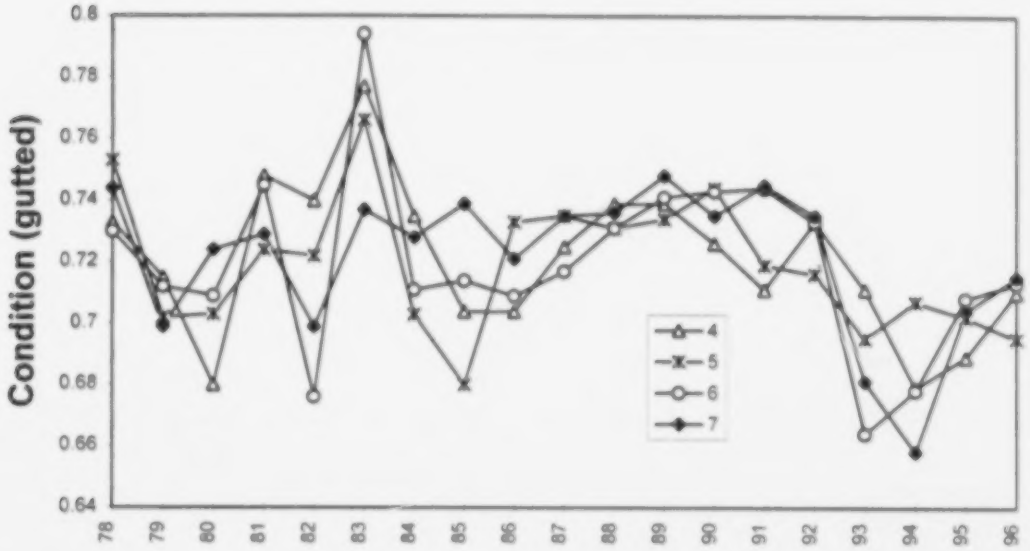

Fig. 6. Mean gutted condition of ages 4-7 cod in Subdivision 3Ps in 1978-1996, as determined from sampling during bottom-trawl surveys in winter-spring.

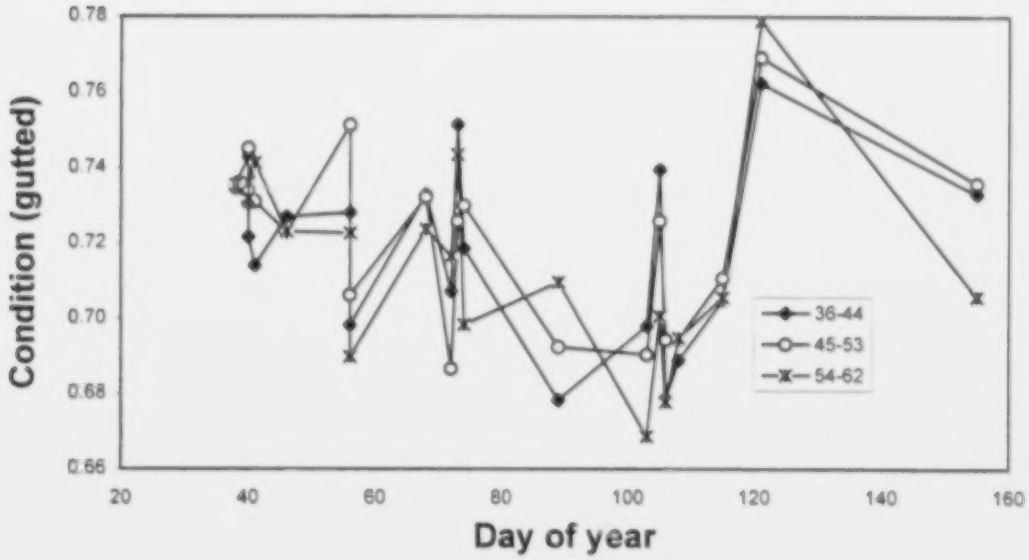

Fig. 7. Mean gutted condition of cod of three length-groups as determined from sampling during bottom-trawl surveys in 1978-1996. The condition values for each year are plotted against the median day of sampling. For years 1993-1996 the median days were 103, 106, 108 and 115, respectively. The only year when sampling occurred at about the same time was 1984 (median day = 105).

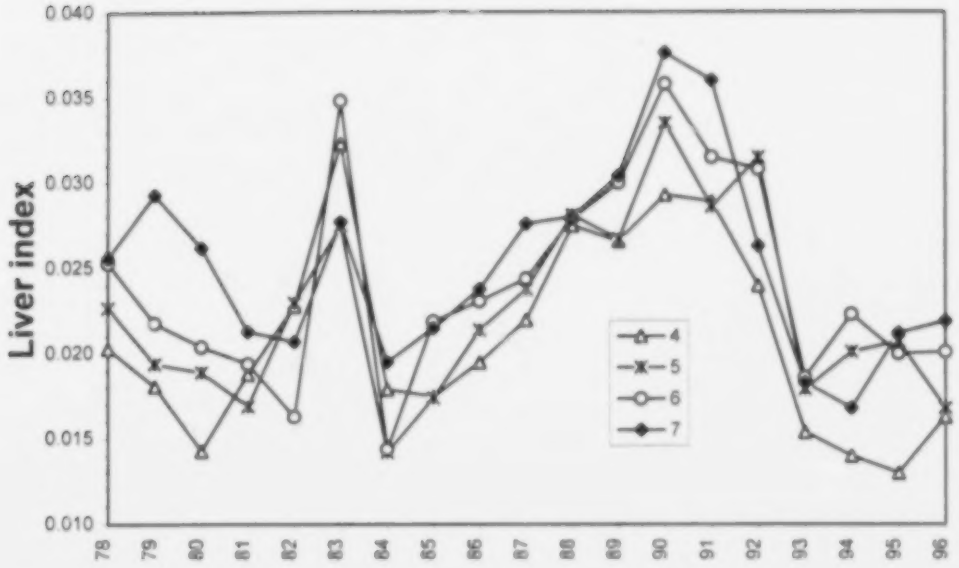

Fig. 8. Mean liver index of ages 4-7 cod in Subdivision 3Ps in 1978-1996, as determined from sampling during bottom-trawl surveys in winter-spring.

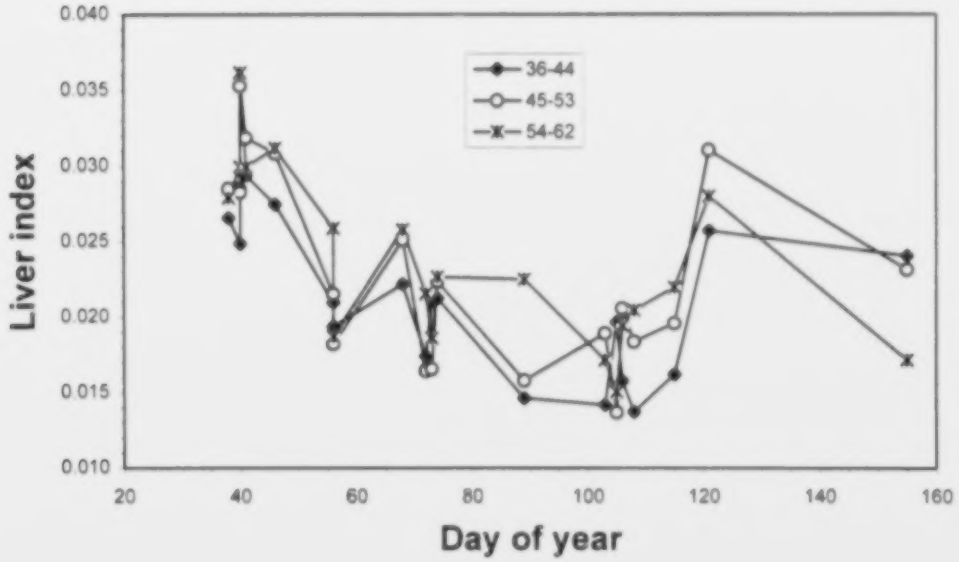

Fig. 9. Mean liver index of cod of three length groups as determined from sampling during bottom-trawl surveys in 1978-1996. The liver index values for each year are plotted against the median day of sampling. for years 1993-1996 the median days were 103, 106, 108 and 115, respectively. The only year when sampling occurred at about the same time was 1984 (median day = 105).

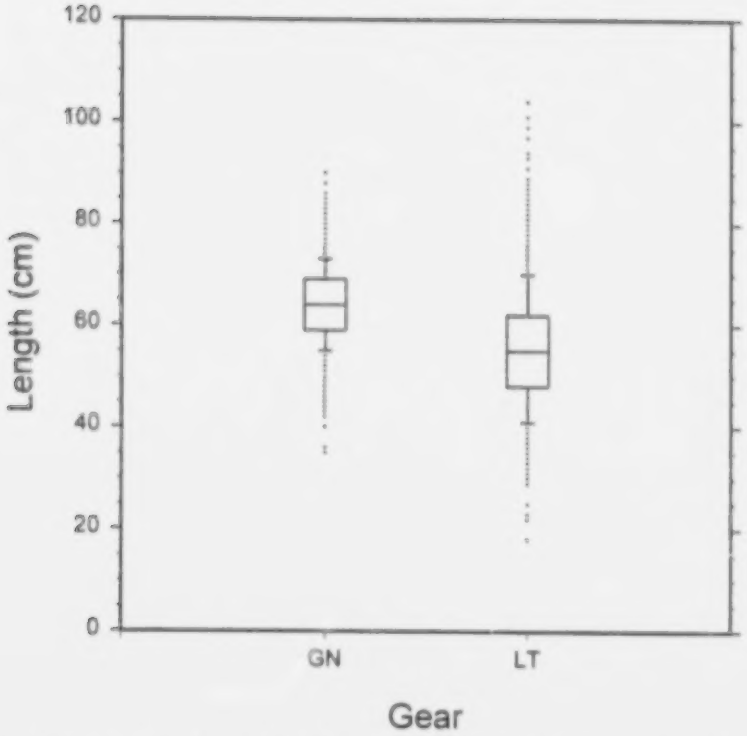

Fig. 10. Lengths (cm) of cod sampled from gillnet (GN) and linetrawl (LT) catches during sentinel surveys in Subdivision 3Ps in 1995. Each box plot illustrates the median, quartiles, 10th and 90th percentiles, and all data beyond the 10th and 90th percentiles.

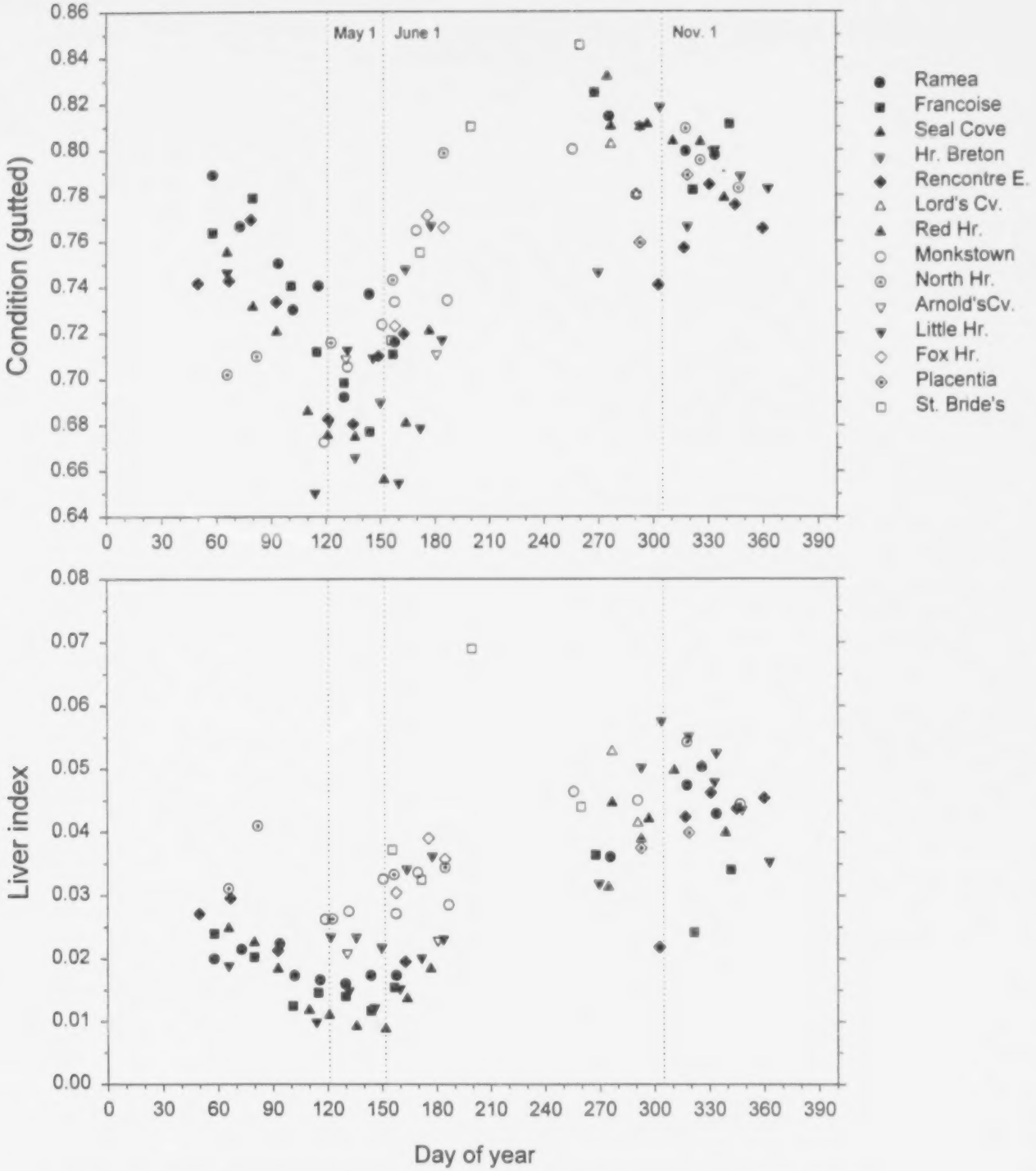

Fig. 11. Condition of cod sampled during the sentinel survey in Subdivision 3Ps in 1995. The data are aggregated by community and day of year. Only cod in the length range 45-71 cm are included. Only points represented by at least 5 fish are plotted. In the legend, communities are ordered from west (top) to east. The black symbols indicate communities to the west of the Burin Peninsula.